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# Ginseng Culture

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COVER ILLUSTRATION — Forest planting of ginseng.

# GINSENG CULTURE

Prepared by the *Division of Tobacco, Medicinal, and Special Crops,*  
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**G**INSENG is a fleshy-rooted herb native to the United States. The commercial importance of the plant is limited; the only demand for it is by Chinese and Koreans, who believe that dried ginseng roots have medicinal value.

The first exports of roots were made in the early part of the last century, but for over 50 years the American ginseng industry consisted simply of collecting and exporting roots of wild plants. Supplies of wild ginseng gradually diminished as a result of overcollection, and high prices caused by the short supply resulted in attempts during the 1880's to cultivate the crop. Cultivation proved possible, and since 1900 a large part of the ginseng production has shifted from forest areas to specially prepared gardens.

Successful ginseng culture depends to a large extent upon the ability of the grower to provide environmental conditions resembling those which are favored by wild plants. Wild ginseng has been most frequently found in shady, well-drained sections of

hardwood forests. Production of wild roots was greatest in an area extending across the northern part of the country from Maine to Minnesota, and in the Appalachian Mountain region.

Cultivation of the plant is not recommended for the Great Plains, the Southwest, or most of the South. Wisconsin has reported the largest plantings in recent years, although even there less than 100 acres have been devoted to the crop. The Census of Agriculture also lists small acreages of ginseng in Arkansas, Minnesota, North Carolina, Oregon, Pennsylvania, and Washington in 1949.

## THE GINSENG PLANT

American ginseng<sup>2</sup> (fig. 1) in its wild state grows from 8 to 20 inches high and bears 3 or more compound leaves. Each leaf consists of 5 thin, stalked, ovate leaflets which are pointed at the apex and rounded or narrowed at the base. The upper 3 leaflets are larger than the 2 lower ones. A cluster of 6 to 20 small greenish-yellow flowers is produced in mid-summer. Bright-crimson berries grow in place of the flowers later in the summer. Each berry contains from 1 to 3 flattish wrinkled seeds the size of small peas. The berries of northern ginseng rarely contain 3 seeds, but berries of

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<sup>2</sup> *Panax quinquefolium* L. of the Araliaceae family.

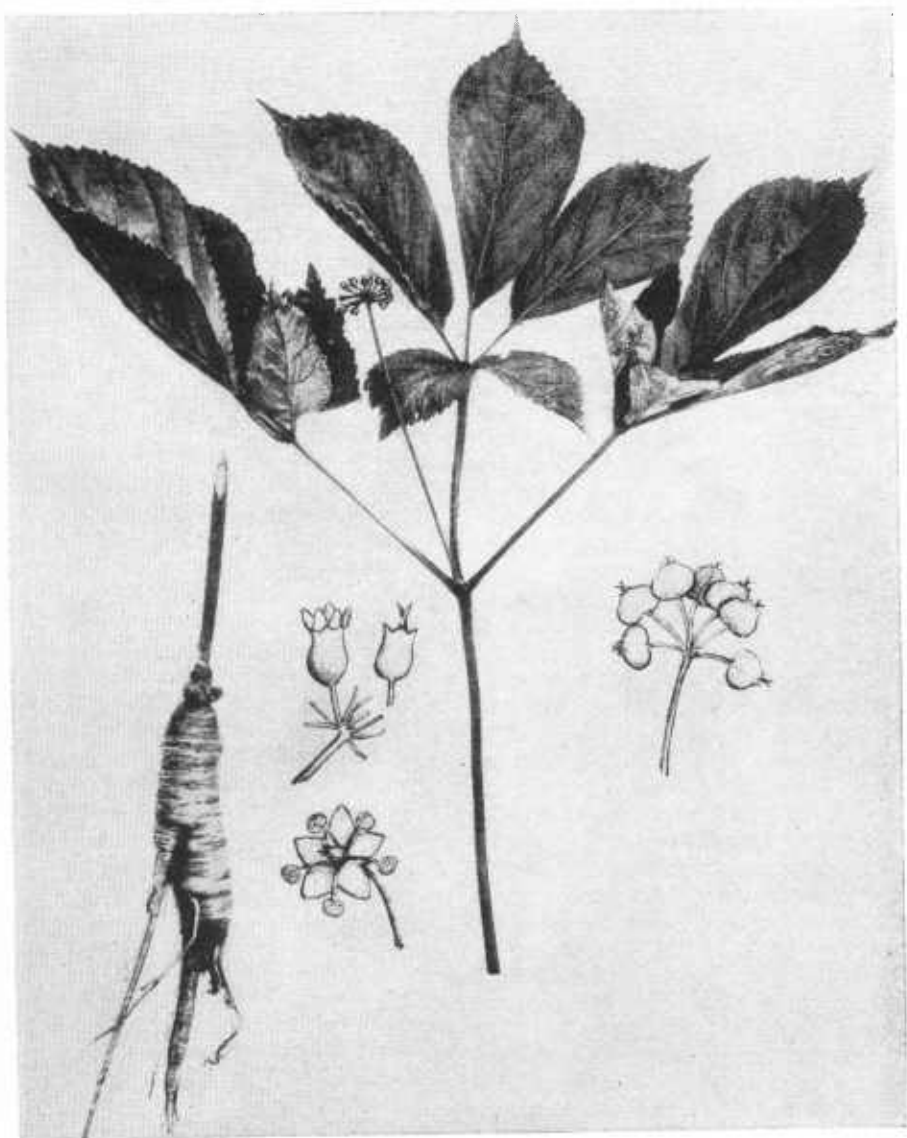


Figure 1.—Branch, root, flower, and berries of American ginseng.

southern ginseng often contain 3 seeds.

The root is  $\frac{1}{2}$  to 1 inch or more in thickness, spindle-shaped, and 2 to 4 inches long. Roots in the older specimens are generally branched and prominently marked with circular wrinkles. The seeds (fig. 2) are slow in germinating and should never be per-

mitted to become dry. As soon as they are gathered they should be mixed with twice their bulk of moist sand, fine loam, sawdust, or woods earth, and stored in a damp, cool place until they are planted. Seeds are collected after they ripen in the fall, but as a rule they will not germinate the following spring.



Figure 2.—Seeds of American ginseng (natural size).

Ginseng seedlings grow about 2 inches high the first year, with 3 leaflets at the apex of the stem. The second-year plants may reach a height of 5 or 6 inches, and bear 2 compound leaves, each composed of 5 characteristic leaflets. A third leaf is generally added the next year, when fruits may be expected. In succeeding years a fourth leaf is formed, and the fruiting head reaches maximum development. A single plant of southern ginseng sometimes produces as many as 300 seeds. Northern ginseng rarely produces more than 100 seeds to the plant, and under cultivation the number seldom exceeds 40.

### RACES OF GINSENG

There are no distinct varieties of American ginseng, but characteristics vary according to the geographical area in which plants grow. Plants from the northern part of the country, particularly those native to New York and Wisconsin, appear to possess the most useful characteristics and form and the best basis for breeding stocks. Southern ginseng grows well when introduced in the North, forming roots of good size and shape, but produces few seeds

until it becomes adapted to the climate. Some of the western types have long, thin roots of undesirable character. The beginner should try to get the best commercial type ginseng as a foundation for his breeding stock.

### SUITABLE SOILS

Soil and location are very important in the culture of ginseng, as it is a plant that grows naturally on the slopes of ravines and in other well-drained situations where the soil is formed from the acid leaf mold of hardwood forests. The soil should be naturally dry, fairly light, and in a condition to grow good vegetables without the addition of manure. Very sandy soil tends to produce hard, flinty roots of inferior value. Although almost any fairly good soil can be brought into a condition suitable for ginseng by sterilizing, the cost is usually high. The addition of leaf mold from hardwoods or old rotted hardwood sawdust conditions the soil, since ginseng requires an acid soil. For seedbeds about 3 or 4 inches of woods earth should be spaded into the soil. If the resulting mixture is inclined to be heavy, enough sand should be added so the mixture will not bake or harden even after heavy rains.

### GROWING THE CROP

Before the diseases of ginseng became such a menace to the industry, practical growers advised the starting of ginseng plantings with both young roots and seeds. By planting roots 3 years old, or older, a moderate seed crop may be had the first year, and a stock of 1-year and 2-year roots set at the same time will start the rotation which is necessary to provide for a marketable crop of roots each year after the first crop is harvested. However, unless

the grower can be sure of obtaining disease-free roots it appears to be the better policy to depend entirely on seeds.

Ginseng seeds are sometimes advertised for sale by growers, and the seeds from wild plants may be purchased from collectors or nursery companies in sections where native stands of ginseng still exist. Seeds are often sold by weight, and it is estimated that 1 pound of average northern seed should produce 7,000 to 8,000 plants, and 1 pound of average southern seed 10,000 plants or more. Stratified seeds (seeds stored in layers in damp sand) usually cost more than fresh seeds, but are regarded as far more satisfactory. As the output of seeds is likely to become greater than is necessary to extend the plantation, it is well to restrict seed production by nipping the flower heads unless a good market for the seeds is assured. Roots gain more rapidly in size and weight if the plants are not permitted to seed.

## Planting

Except in the far Northwest it is best to sow ginseng seeds in the fall. If they are held until spring, growth may start before they can be sown, and thus many may be lost. Only scarified or germinated seeds should be used. They should be sown 8 inches apart each way in permanent beds, or 2 by 6 inches in seedbeds. Plants started in seedbeds should be transplanted when 2 years old to stand 8 inches apart. The seeds should be covered 1 inch deep with woods soil or old rotten hickory or basswood sawdust. Pine or oak sawdust should not be used. Roots may be set in October or later in the fall if the soil is in suitable condition, the crowns being placed about 2

inches below the surface. The most approved distance to plant is 8 inches apart each way, if roots are to be grown until 7 years old in permanent locations.

Many planters round the surface of the beds, making the center several inches higher than the sides. There is space for more plants on rounded beds than on flat beds, but there is danger of building the centers up so high that roots will be out of reach of soil moisture. It is important, however, to build the centers of the beds high enough to drain off rain water. The paths or alleys should be much lower than the beds, and if they slope from one end to the other they will serve as surface drains during heavy rains. Beds for roots should be worked not more than 6 to 8 inches deep if on ordinary soil. Very heavy soils may be worked more deeply if necessary to obtain better drainage. Seedbeds need not be deeply stirred, as it is not advisable to have them settle to any marked extent. Twelve-inch boards, set 8 inches or more in the ground and nailed to small stakes, may be used as retainers for the sides of built-up beds.

## Shading

Ginseng grows naturally in rather dense shade, and under cultivation it must be shielded from direct sunlight by some construction that will reduce the light to about one-fourth its normal intensity. When it is planted in open ground this may be accomplished by erecting sheds open on all sides, but covered at the top with lath or boards so spaced as to cut out nearly three-fourths of the sunlight. It is not advisable to use burlap or muslin for shading, as these materials interfere with the free circulation of the air.

There are many methods of constructing sheds, but the most com-

mon is as follows: Posts are set firmly in the ground 8 feet apart each way with about 8 feet of the post above the ground. Beams 2 by 4 inches in size are nailed on top of the posts so as to run the long way of the shed. The top is usually made in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches square and 8 feet long. Laths should be spaced  $\frac{1}{4}$  to  $\frac{1}{2}$  inch apart, according to locality. Narrow spacings are recommended for the South, and wider spacings for the North. These sections of shading are laid on top of the 2- by 4-inch beams. The shed should be built so that the laths run about north and south to give the plants below the benefit of

constantly alternating light and shade (fig. 3). Owing to the high cost of lumber, some growers use No. 4 wire in place of the 2- by 4-inch beams.

Artificial shade should be constructed so that it will permit free ventilation, which is necessary for ginseng. "The higher the shade the better" is a maxim worth following, as plants in gardens with a free circulation of air are less likely to become diseased.

Seedbeds under the regulation shade are often further protected by a lower shade to avoid the washing out of seeds by dripping from the laths. This lower shade may be of poultry netting covered with brush, straw, litter, or bur-lap. The density of the covering



Figure 3.—Lath structure affording partial shade, well suited for growing ginseng and other woodland plants.



for the poultry netting should vary according to the season; a light covering is suitable in the spring and more is needed later in the summer as the sun's rays become more direct. Seedlings are apt to damp-off in warm, wet weather in seedbeds which are in the open and have a low shade for the only protection.

Beds for permanent planting under shade should be 4 feet wide, and the shade protecting the beds should be constructed so the drip of rain from the ends of the laths will fall in the pathways.

### Fertilizing

Heavy fertilization tends to lessen the resemblance of the cultivated root to the wild product and consequently reduces its value, as the root most closely resembling the wild in appearance and texture is in greatest demand. Over-feeding also forces growth and thereby renders the plant less resistant to the attacks of disease. Lime and wood ashes have been used by many growers on their ginseng beds, but either root rust or fiber rot has almost invariably followed their use. If lime is used at all, it is well to apply it at least a year before planting. Serious leaf injury has followed the excessive use of nitrogenous fertilizers, and heavy applications of barnyard manure have also caused severe injury. Experienced growers recommend a good rich soil to start with and very moderate forcing.

The best method of fertilizing is to add 4 to 6 inches of woods soil or rotted leaves and spade in to a depth of about 8 inches. Fine raw bonemeal should then be raked in at the rate of 1 pound to each square yard. If barnyard manures are used they should be thoroughly rotted, and worked in

some months previous to planting the beds. Some growers advise against the use of animal manures or even a soil to which they have been heavily applied.

### Cultivating

Ginseng requires little cultivation, but grass and weeds should be kept out of the beds, and the surface of the soil should be scratched with a light tool whenever it shows signs of caking. Ordinarily one active man can easily care for about 2 acres of ginseng.

### Mulching

A winter mulch over the crowns is essential, especially in northern localities. Seedling beds particularly require careful mulching to prevent heaving by frost.

Forest leaves held in place with poultry netting, light brush, or sawdust are the most desirable mulches. Cornstalks stripped of the husks, bean vines, cowpea hay, buckwheat straw, or other coarse litter not containing weed seeds or material attractive to mice are also satisfactory. Mulches should not be placed in position until actual freezing weather is imminent, and they should be removed in the spring before the first shoots come through the soil.

A mulch of 4 or 5 inches of leaves or their equivalent in litter is ample for the severest climate, and less is needed in the South. A light summer mulch of sawdust helps keep down weeds and prevents excessive loss of moisture in dry weather.

### Drainage

In laying out ginseng beds provision must be made for efficient drainage. The preferable location

is on ground that has a gentle slope, but as natural drainage cannot always be depended on to remove excess water from beds, some type of underground drain must be employed. Satisfactory results have been obtained by the use of clay or cement drain tile in ginseng beds. A line of tiles should be placed under the center of each bed. The proper depth of the drain will vary with the character of the soil, and the size of the tiles will depend on the amount of rainfall. In general, if 3-inch tiles are used the drains should be placed 1½ to 2 feet deep in clay and 3 to 4 feet deep in sand or gravel.

## **FOREST PLANTINGS**

The earlier successes with ginseng culture were made with plantings in hardwood forests, and this method is still preferred by many growers when a suitable location is available. Yield from forest plantings is said to be about one-half that obtained under artificial shade, but production costs are much less in forest plantings. Growers on the Pacific coast have found that ginseng cannot be grown successfully under tree shade in that region.

Beds in forest plantings should be placed where the shade is continuous and fairly dense. The shade should be produced by tall, open-headed, hardwood trees rather than by undergrowth, to insure free circulation of air. Some experienced growers prefer to plant on land that slopes to the north, thereby providing the coolest location during the heat of the summer. The soil should be deeply plowed or spaded and all tree roots removed. The growth of tree roots into the beds should be prevented by occasionally cutting around the beds with a sharp spade. A liberal quantity of leaf

mold or well-decayed litter should be worked into the soil, and an application of bonemeal raked into the surface is usually desirable. Ginseng may be planted closer under forest conditions than in garden culture, but with either practice the closer the plants stand the greater is the danger from disease. The culture of forest beds is in all respects similar to that of beds under artificial shade. Winter mulches should never be omitted.

## **PROTECTION**

Owing to the comparatively high cost of ginseng plants and roots, the beds should be well fenced to prevent the intrusion of wild or domestic animals and should also be carefully guarded against theft, which is not uncommon with this high-priced product. Such protection is especially needed with forest plantings. Moles may be controlled with suitable traps, of which several kinds are on the market. If 12-inch boards are used to retain the sides of built-up beds, they are also effective in stopping moles. Mice often cause great damage to ginseng, but they can be kept from the beds by wire netting of sufficiently close mesh set 12 to 18 inches in the ground.

## **DIGGING AND DRYING THE ROOT**

The cured root is valued by the Chinese according to its size and maturity. Mature roots of the most desired quality break with a somewhat soft and waxy fracture, and sell readily at top quotations. Young roots dry hard and glassy and are regarded as less desirable. Very small young roots and root fibers are often sold for less than a dollar a pound. Under-sized or stunted roots of suitable

age, however, are readily salable. Cultivated roots as a rule attain greater size than wild ones of the same age. They are harder and denser than the wild roots on account of their more rapid growth, and will lack in flavor and quality if harvested before they are about 5 years old.

Beds should rarely be dug for market until about the sixth year. All roots should then be taken up. Replanting the undersized or stunted roots is of doubtful value, since they frequently make little more growth. Good roots should be nearly 4 inches long and half an inch in thickness below the crown and should average about an ounce in weight in the fresh state.

Roots may be dug at any time after growth ceases in September, but mid-October is regarded as the most favorable time. They should be carefully washed or shaken free of all adhering soil, but not scraped or scrubbed, as it is important to preserve the natural dusky color of the skin with its characteristic annular markings.

The older roots possess the most substance and when properly cured bring the highest prices. In recent years a demand for ground ginseng has established a market for young roots, which are preferred for milling on account of their hard, flinty texture.

Drying should be done in a well-ventilated room heated by a stove or a furnace. It has long been customary to start drying between 60° and 80° F. and after a few days to increase the temperature to about 90°. Some growers now recommend that drying start between 100° and 110° and that the temperature be reduced to about 90° as soon as the roots are wilted. The roots are spread thinly on lattice trays or

shelves made of wire netting and are frequently examined and turned. They must always be handled carefully to avoid breaking the forks or marring the surface.

Roots measuring more than 2 inches in diameter will need to be dried for about 6 weeks, but smaller roots may be properly dried in less time. In all stages of curing, especially in noticeably damp weather, particular care should be taken to see that the root does not mold or sour, as any defect will greatly decrease the selling price. However, overheating should be avoided, as it tends to discolor the surface and spoil the texture of the interior. Cured roots should be stored in a dry and airy place, secure from vermin, until ready for sale.

### **DISEASES AND THEIR CONTROL <sup>3</sup>**

Cultivated ginseng is frequently subject to severe attacks of a number of diseases, the development of which appears to be especially favored by crowding of the plants, excess water in the soil, and lack of proper ventilation.

Plants growing wild are as a rule thinly scattered on the forest floor where there is favorable ventilation and soil drainage. Diseases are not likely to spread under such conditions. Under the crowded conditions of commercial culture, however, diseases tend to spread and may cause material injury. Errors in fertilization and soil treatment are also frequent causes of injury and by weakening the resistance of the plants may further invite the inroads of disease.

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<sup>3</sup> Prepared by S. P. Doolittle, senior pathologist, Division of Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering.

## **Alternaria Blight and Root Rot <sup>4</sup>**

Alternaria blight is one of the most widespread ginseng diseases and affects both leaves and roots. During the spring the stems of diseased plants show dark-brown cankers just above the ground line, which enlarge and become covered with a velvety-brown coating of the spores (microscopic seedlike bodies) of the fungus causing the disease. Later in the season, large water-soaked spots develop on the leaves and eventually become papery and dry with a darker, yellow-brown margin.

Later the leaflets may droop where the leafstalk rises at the top of the stem, and brown spore masses may form again at this point. Seed heads are affected, and when such infection occurs the berries often shell. When roots are attacked they rot very slowly, and there is no odor. The lesions are dark brown or black, and the rotted roots remain firm. Root infection apparently occurs only in roots that have been injured.

The spores of the fungus are distributed by the wind and may be carried on clothing from diseased to healthy beds. During moist weather the spores that have lodged on the plants germinate and produce further infection. Because the fungus also lives over winter on diseased leaves and stems of the previous season, it is important that diseased tops be removed and destroyed. After the tops die down the beds also should be disinfected by being soaked down to a depth of an inch with a solution of 1 pound of copper sulfate to 7 gallons of water. The most effective means of control, however, consists of spraying the plants during the growing season with a 3-3-50 bordeaux mixture to which 2 pounds of cal-

cium arsenate have been added. The first application should be made when most of the plants have broken through the soil, the second when the leaflets are fully spread, the third just before blossoming, and the fourth after the fruits are set.

Bordeaux mixture can be purchased in paste and powder form for use in small plantings. Fresh mixtures are more effective, however, and can be made at home by the following formula: Dissolve 3 pounds of copper sulfate in hot water, using a wooden or earthenware vessel, and dilute to 25 gallons with water. Slake 3 pounds of stone lime (or 5 pounds of hydrated lime) in a small amount of water and dilute to 25 gallons. Pour the two solutions together while stirring and add 2 pounds of calcium arsenate. Small quantities of the spray may be prepared by mixing 3 ounces of copper sulfate and 3 ounces of stone lime (or 5 ounces of hydrated lime) in 3 gallons of water and adding 2 ounces of calcium arsenate.

## **Phytophthora Mildew and Root Rot**

Phytophthora mildew and root rot is a fungus disease that affects leaves, stems, and roots of plants of all ages and frequently is very destructive. The leaflets at the top of the diseased plants often droop at the base of the petiole in much the same manner as in alternaria blight and the stems become hollow and discolored. The leaf blades also show spots that in their earlier stages resemble those of alternaria. Centers of the spots become white, but the margins remain a dark, water-soaked green and do not show the yellow-brown border characteristics of alternaria spots. Infected roots develop a soft rot and eventually are in-

<sup>4</sup> See List of Fungi that Cause Ginseng Diseases at the end of this bulletin.

vaded by other organisms which produce a disagreeable odor.

This fungus overwinters in the tissues of diseased plants in the soil and spring infection occurs either in roots or stem, but both roots and tops eventually may become diseased.

The most effective control for the disease consists of spraying with bordeaux mixture as for alternaria blight. To prevent the fungus from passing down the stem to the roots, all wilting or drooping tops should be cut off at the crown and removed. Affected roots should also be removed and destroyed, and the bed disinfected with a solution of 1 pound of copper sulfate in 7 gallons of water. Beds that are infested with this fungus should not be used for a number of years. If for any reason infested beds must be used, they should be sterilized with steam<sup>5</sup> or with a solution of 1 part of formaldehyde to 50 gallons of water. In using formaldehyde, all roots are first removed and the ground is loosely spaded. The solution is then applied at the rate of  $\frac{1}{2}$  to 1 gallon per square foot, depending on amount needed to saturate the soil. As soon as it can be worked, the soil should be spaded to allow the formaldehyde to evaporate. This stirring of the soil should be repeated at intervals for at least 2 weeks before any planting is done, as formaldehyde fumes are injurious to growing plants.

### **Acrostalagmus Wilt**

Acrostalagmus wilt is a disease of older plants and rarely causes severe damage. It is caused by a fungus that penetrates the water-conducting vessels of the root and

causes a gradual wilting of the top. Diseased roots seem healthy externally, but when cut across show a yellow zone in the conducting tissue. Diseased roots should be dug and dried to remove the source of infection, and beds where the disease has occurred should be disinfected with formaldehyde or steam.

### **Ramularia Root Rot**

Ramularia root rot or "rust" is caused by a fungus that may attack the roots of plants of all ages, but it is most common on seedlings, which often are rendered worthless. On older roots the spots are a rusty brown but do not penetrate deeply. In seedlings the fine rootlets are damaged and the taproot may become short and knoblike. The disease is favored by an alkaline soil, and where it occurs the use of lime or wood ashes should be avoided.

### **Sclerotinia Rots**

Two ginseng diseases are caused by fungi of the genus *Sclerotinia*. The diseases are sclerotinia white rot, and sclerotinia black rot. Sclerotinia white rot occurs in most sections where ginseng is grown, but rarely causes severe loss. Infected plants develop hard, black bodies inside the stem and on the outside of the root. These bodies, sometimes one-quarter of an inch long, are the resting stage of the fungus and remain in the soil over winter. In the spring they produce small cup-like bodies containing spores which serve as sources of new infection. White rot affects the roots and stem, but does not spot the foliage. Diseased stems lose their green color and become hollow. Infected roots rot rapidly, and the tissues are soft and brittle but without bad odor.

<sup>5</sup> See U. S. Department of Agriculture Farmers' Bulletin 1629, Steam Sterilization of Soil for Tobacco and Other Crops.

White rot also affects many vegetable crops, and this probably explains its presence in beds on soil where such crops have previously been grown. Good drainage and aeration will do much to prevent losses from the disease. Infected plants should be removed and burned and the soil from which they came should be disinfected with a copper sulfate solution, as described for phytophthora mildew (p. 10).

The other disease of this group, sclerotinia black rot, occurs on wild ginseng and also affects the plant known as false solomonseal.<sup>6</sup> It is probably often introduced through forest soil used in making ginseng beds. Black rot attacks only the roots, making little progress during the growing season. Its presence is indicated by failure of certain plants to come up in the spring, and on digging only black, mummylike roots will be found. Sclerotia are formed on these roots as in sclerotinia white rot. All roots in the diseased area should be removed and the soil disinfected by the same method used for white rot.

### Damping-off of Seedlings

Damping-off of seedlings is characterized by a decay of the stem at the surface of the soil, which results in a falling over and death of the affected plants. The disease may be caused by a number of fungi which are commonly present in the soil and whose attacks are favored by excessive moisture and lack of aeration. Good drainage is therefore essential in raising seedlings. Sprinkling sand on the surface of the bed to a depth of  $\frac{1}{8}$  to  $\frac{1}{4}$  inch is also sometimes of value in checking damping-off. When planted in furrows the soil should be kept stirred, particularly after rains.

<sup>6</sup> *Smilacina racemosa* (L.) Desf.

If seedbeds can be sterilized with formaldehyde before planting, losses from damping-off usually can be greatly reduced.

### Root Knot <sup>7</sup>

Root knot, a serious disease affecting more than 1,850 kinds of plants, is found on ginseng roots in many regions, but is more prevalent in warm climates. It is caused by nematodes, or eelworms, belonging to the genus *Meloidogyne*. The adult nematodes live in galls on the underground parts of the plants; larvae live in the soil. Galls start as very slight swellings, but may reach a diameter of one-half inch or more. It is possible to see the shiny, white, pear-shaped female nematodes inside the galls. The nematodes are smaller than a pinhead, and a hand lens is helpful in locating them. This disease damages or destroys ginseng seedlings. The misshapen mature roots of diseased plants have a reduced market value.

Ginseng may become infected with root knot either in the seedbed or after transplanting, if the soil contains nematodes. Ginseng growers should use land that is free from root-knot nematodes both for seedbeds and the growing of the crop. If soil does become infested, nematodes can be controlled by steam or by fumigation. Control can be accomplished by running steam through lines of 3- or 4-inch tiles buried 18 to 22 inches apart and 15 to 18 inches deep. Steam can also be run through perforated pipes laid temporarily. A temperature of 200° F. should be maintained throughout the soil for half an hour.

<sup>7</sup> Prepared by Edna M. Buhner, associate nematologist, Division of Nematology, Bureau of Plant Industry, Soils, and Agricultural Engineering.

Recently, however, fumigation of infested soil with certain chemicals before planting has been found to be a more practical control measure. The fumigants most commonly used in the field are mixtures containing dichloropropene (such as D-D and Nema-fume) and those containing ethylene dibromide (such as Dow-fume W-40, Soilfume 60-40, Iscobrome D-42, Bromofume 40, and Iscobrome D). Chloropicrin (Larvacide), methyl bromide (MC-2), methyl bromide mixture (MBX), and chlorobromopropene (CBP), in addition to controlling nematodes, also control certain other soil pests and diseases, and are recommended for seedbed use.

Control is particularly important in the seedbed, because plants infected there will never grow properly and will spread the disease. Seedlings should be carefully inspected for evidence of root knot before transplanting.

All of these fumigants, except methyl bromide (MC-2), are liquids. They are applied by injection into the soil at closely spaced intervals by either hand applicators or applicators attached to tractors. Methyl bromide is applied as a gas by releasing it under a gastight cover. Details of application procedures for soil fumigants and precautions on their use can be obtained from manufacturers and distributors of the fumigants.

## **YIELD AND VALUE OF THE CROP**

The yield of cultivated ginseng varies greatly and depends largely on the suitability of the condi-

tions under which the crop is grown and on the skill and experience of the grower. It has been estimated that the roots from a bed measuring 4 by 16 feet, if dug when 6 years old, should weigh about 10 pounds when dry. Yields of dry root from well-managed plantings average about a ton to the acre, although much larger yields are frequently reported.

Prices paid for ginseng have fluctuated greatly depending on world conditions. The value of exported roots during the period 1920-29 ranged between \$8.29 per pound in 1921 and \$15.13 in 1923, and averaged \$12.70 per pound. Between 1930 and 1939 average value was \$5.40 per pound with a high of \$9.24 in 1930 and a low of \$3.62 in 1933. During World War II there was practically no export of roots but in 1946 shipments increased to 185,876 pounds, which was about the level of prewar exports. A downward trend in exports started in 1947 and continued through 1951, when only 76,999 pounds were shipped. The declared value of exported roots ranged between \$10 and \$12 per pound from 1945 through 1950 and reached \$17.57 in 1951.

The market for ginseng is small and the industry affords an opportunity for only a limited number of growers. A yearly production of 100,000 pounds, which was the approximate level of exports for the period 1947-50, can be obtained on fewer than 100 acres. This would represent total plantings of no more than 500 to 600 acres, since at least 6 years are required to grow marketable roots from seed.

## LIST OF FUNGI THAT CAUSE GINSENG DISEASES

<i>Name of disease</i>	<i>Causal organism</i>
Acrostalagmus wilt .....	<i>Acrostalagmus</i> sp.
Alternaria blight and root rot .....	<i>Alternaria panax</i> Whetzel.
Phytophthora mildew and root rot .....	<i>Phytophthora cactorum</i> (Cohn. & Leb.) Schröter.
Ramularia root rot .....	<i>Ramularia</i> sp.
Sclerotinia black rot .....	<i>Sclerotinia smilacina</i> Dur. = <i>S. panacis</i> Rankin.
Sclerotinia white rot .....	<i>S. sclerotiorum</i> (Lib.) Massee.

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